

## Research Article

# Diversity of Epiphytic Orchids, Hoya, Dischidia and Phorophytes (Host Trees) in Bawean Island Nature Reserve and Wildlife Reserve, East Java, Indonesia

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### ABSTRACT

Bawean Island is a small island located between two islands (Java and Borneo). Geographically, the diversity of plants, especially epiphytic plants on this island is very interesting to be studied. This research aims to investigate the diversity of epiphytic plants, focussing on epiphytic orchids, Hoya and Dischidia in Bawean Island Nature Reserve and Wildlife Reserve. It was conducted through an inventory of epiphytic orchids and hoyas growing on host trees. The results showed there were 10 species of epiphytic orchid and 3 species of epiphytic Hoya, and 1 species of Dischidia growing on-location studies. The epiphytic orchids which found in location studies included *Phalaenopsis amabilis*, *Aerides odorata*, *Cymbidium aloifolium*, *Dendrobium anosmum*, *Rhynchostylis retusa*, *Liparis condylobulbon*, *Taeniophyllum biocellatum*, *Cymbidium* sp., *Eria* sp. Orchid species that most often found in the study location was *Phalaenopsis amabilis*. In addition, this study recorded *Taeniophyllum biocellatum* as an endemic orchid from Java that was found on this island. The epiphytic Hoya recorded in there, i.e. *Hoya diversifolia*, *H. verticillata*, and *H. amoena*, and also only found 1 species of Dischidia was *Dischidia imbricata*. There were 12 species of trees as the host trees of epiphytic, i.e. *Irvingia malayana*, *Tectona grandis*, *Diospyros buxifolius* were the host trees frequently found as the host of the epiphytic plant. Zone 3 as an area of 1/3 basal part of a total length of the branches was the most preferred zone by epiphytic orchids and hoyas. The epiphytic orchid and hoyas hardly found in Zone 5.

**Keywords:** Bawean, dischidia, epiphyte, hoyas, orchid

### INTRODUCTION

Bawean island is one of the small islands located between Borneo and Java islands which leads to the unique biogeography of the island. The diversity of flora and fauna in the Bawean Island consists of Wildlife Reserve with an area of 3,836.6 Ha and Nature Reserve with an area of 725 Ha (Ministry of Agriculture of Indonesia, 1979). The topography of Bawean Island Wildlife Reserve and Nature Reserve is hilly, mountainous and bumpy. The altitude of the region ranges from 200-687 m above sea level. Based on the observation of the altitude, the highest altitude of Gunung Lumut Forest was 687 m above sea level.

The discovery of endemic species such as Bawean deer *Axis kuhlii* (Semiadi *et al.*, 2015), new

species of butterfly *Atrophaneura coon* sub. sp. *sangkapurae* (Maurizio & Salla, 1992), some endemic birds of *Falconiformes* and *Strigiformes* (Nijman, 2004), Javan warty pig *Sus verrucosus* (Blouch, 1995), Bawean warty pig (*Sus blouchi*) (Rademaker *et al.*, 2016), indicated that Bawean Island, which is rich with bioresources, can be an interesting subject to be studied. Some inventory studies and assessments on flora biodiversity in Bawean Island have been conducted sporadically in a few past years. Most important and common trees species found in some montane forests are *Irvingia malayana*, *Ficus variegata*, and *Myristica guatteriaefolia* (Danarto and Rahadianoro, 2015; Trimanto, 2014; Trimanto and Hapsari, 2016).

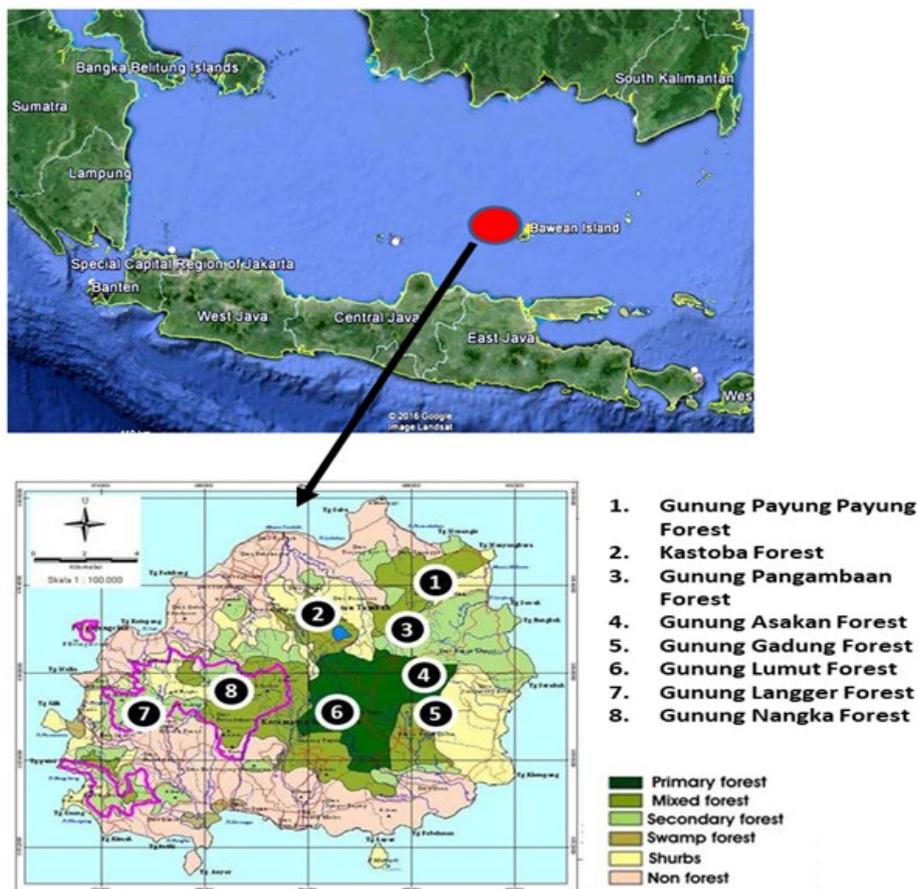
There is a paucity of data and information on the diversity of epiphytes, especially epiphytic orchids and Hoya in Bawean Island Nature Reserve. Epiphytic plants are plants that grow on the other plants (host trees) but are not parasitic, they can

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**Figure 1.** Location of epiphytic plants in Bawean Island, East Java. (Source: Bawean Island Natural Resource Conservation Center and Google Earth 2003).

photosynthesize to provide nutrients for themselves. Ecologically, epiphytes have important roles as they can be used as a bioindicator for the condition of abiotic factors such as humidity, temperature and light intensity in an area. The diversity of epiphytic plants is greatly influenced by microclimates and tree stands (Setyawan, 2000)

This study aims to investigate the epiphytic orchids, *Hoya* and *Dischidia* in Bawean Island Nature Reserve and Wildlife Reserve while also can contribute to the scientific documentation and data of the diversity of plants in Bawean Island. This information can be developed into a guide and basis for recommendations on plant conservation policies at the local level as well as modeling for plant conservation strategies on small islands.

**METHODS**

**Location and Materials**

The study was conducted in 2014 and located in Bawean Island Nature Reserve and Wildlife Reserve (Figure 1). This research used a purposive sampling method covering eight Gunung forest, they are Gunung Langger forest, Gunung Gadung forest, Gunung Asakan forest, Gunung Nangka forest, Gunung Payung-payung forest, Gunung

Pangambaan forest, Kastoba forest, and Gunung Lumut forest with 20 plot for each Gunung forest (each plot’s size is 10m x 10m) were used in this study. Materials used for this study i.e. tally sheets, alcohol 70%, labels, and herbarium sheet while the tools used in this study i.e. GPS, binoculars, and magnifying glasses.

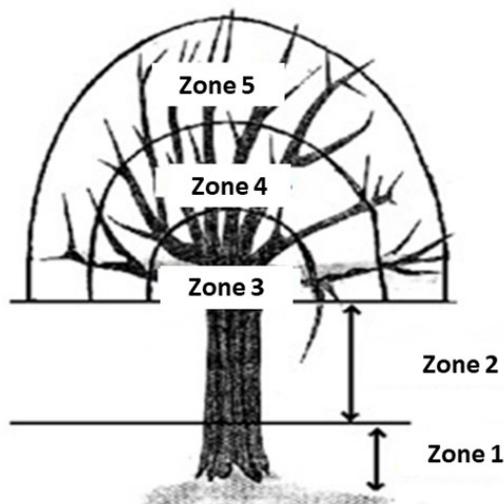
**Data Collection**

The method used in this orchid inventory is exploratory. Observations on the epiphytic orchids, *Hoya* and *Dischidia* growing on the host trees were conducted. The vertical distribution of the epiphytic orchids and hoya was recorded based on Johansson’s methods (1974), which divide host trees into 5 zones (Figure 2):

- Zone 1: Area covering the base of the tree (1/3 of the main trunk)
- Zone 2: Area from the main trunk of the tree to the first branch (2/3 of the main trunk)
- Zone 3: The area covering the basal part of the branching (1/3 part of the total length of the branch)
- Zone 4: The area covering the middle part of the branch (1/3 of the following middle part)
- Zone 5: Outermost area of branching (1/3 of the

outermost branching)

The data recorded are the species name of epiphytic plant, the species name of host tree, the number of epiphytic species on host tree, and the number of host tree. For each orchid, Hoya and Dischidia that unidentified in location study needs to be made its herbarium and then the identification process was carried out in Herbarium of Purwodadiensis. An environmental condition such as altitude measured around the habitat of epiphytic plants found at the study site and then recorded on tally sheets.



**Figure 2.** Illustration of host zoning of epiphytic plants by Johansson, 1974. (Source Figure: Aulia and Hakim, 2019).

**Data Analysis**

The research measured and analyzed some parameters with a relative abundance of epiphytic (% Fo), frequency of phorophyte (% Ft), the average number of individuals of orchids of each phorophyte species (Ji/Jt), the average number of epiphytic orchid species on a phorophyte species (Js/Jt), and the vertical distribution of the orchids on the phorophytes (Nurfadilah, 2016; Yulia & Budiharta, 2011; Yulia & Budiharta, 2012).

1) Relative Frequency of Host trees (%Ft)

$$\% Ft = \frac{Nt}{\text{Total number of all phorophytes}} \times 100\%$$

where: Nt = the number of trees in the plot hosting a particular epiphytic species.

2) Abundance of epiphytic plants (% Fo)

$$\% Fo = \frac{No}{\text{Total number of all epiphytic species}} \times 100\%$$

where: No = the number of individuals of a particular epiphytic species.

3) Average number of individual epiphytic on each host plant (phorophytes)

$$= \frac{Ji}{Jt}$$

where: Ji = the number of epiphytic individuals.

Jt = the number of individuals of each phorophyte species.

4) The average number of epiphytic species on a phorophyte species

$$= \frac{Js}{Jt}$$

where: Ji = the number of epiphytic species.

Jt = the number of individuals of each phorophyte species.

Vertical distribution of orchids (zoning) on the host tree was calculated from the number of species in zone, orchid species on the phorophyte, from the trunk to outer branches in five zones (zone 1, zone 2, zone 3, zone 4, and zone 5) and by calculating the average number of individuals of epiphytic orchids in each zone. Percentage of epiphytic on every zone was calculated from number present of epiphyte species in each zone/total of present in all zone.

**RESULTS AND DISCUSSION**

There were 10 species of epiphytic orchid, 3 species of Hoya and 1 species of Dischidia (Table 1). The results of the present study showed that the number of phorophyte species hosting each epiphytic varied from 1 to 3 species of phorophyte (host trees). Epiphytic plants occurred on a single phorophyte and multiple phorophytes. Some epiphytic plants occurred on a single phorophyte such as *Aerides odorata*, *Dendrobium anosmum*, *Liparis condylobulbon*, *Pholidota imbricata*, *Taeniophyllum biocellatum*, *Hoya diversifolia*, *Eria* sp. Other Epiphytic plants occurred on multiple phorophytes such as *Phalaenopsis amabilis*, *Cymbidium aloifolium*, *Rhynchostylis retusa*, *Hoya verticillata* and *Dischidia imbricata*. The results of the present study were similar to other studies which showed that the number of phorophyte species hosting epiphytic orchids varied from a single to multiple phorophyte species (Nurfadilah, 2016; Adhikari *et al.*, 2012). *P. amabilis* is an epiphytic orchid with the highest phorophyte species. Some species of epiphytic have not specific phorophyte. Umiyah *et al.* (2011) reported that epiphytic orchids in Sempu Island have not specific species of host trees but generally grow under canopy cover.

**Table 1.** The epiphytic orchids, Hoya, Dischidia and the phorophytes in the Bawean Island Nature Reserve and Wildlife Reserve.

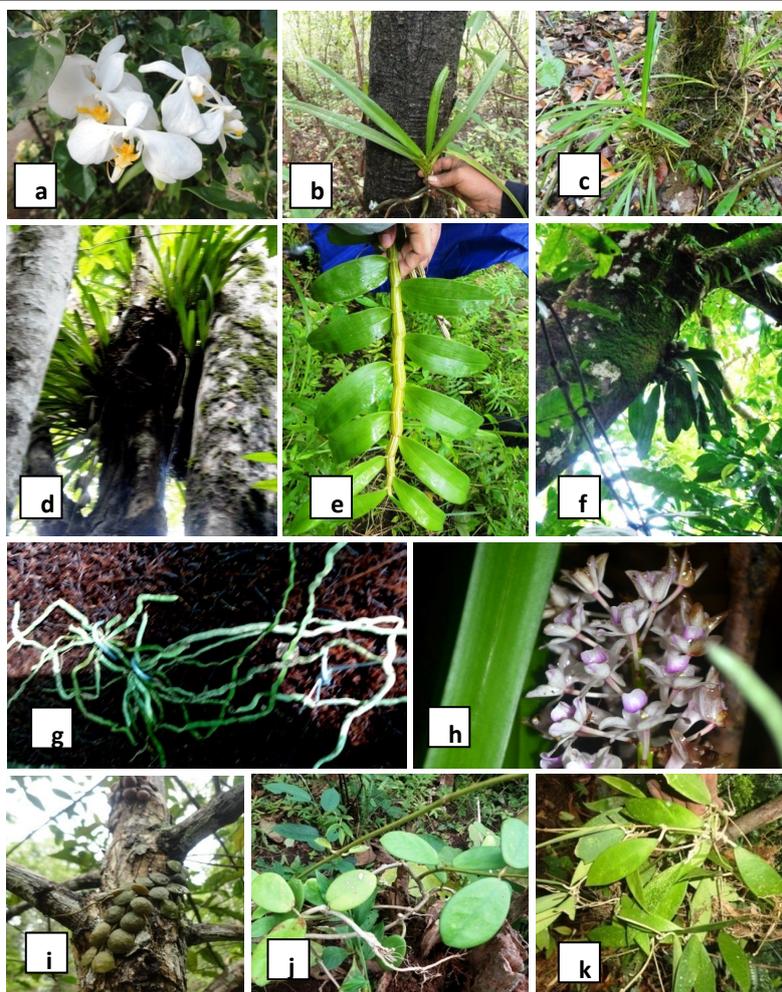
No	Species	Number of Host Trees Species	Host Trees	Zone	Location	Altitude
1	<i>Phalaenopsis amabilis</i>	3	<i>Euonimus javanicus</i>	Zone 3	Gunung Langgar Forest	167 m asl
			<i>Tectona grandis</i>	Zone 1,2	Gunung Langgar Forest	167 m asl
			<i>Tectona grandis</i>	Zone ,1, 2, 3 and 4	Gunung Gadung Forest	195 m asl
			<i>Garcinia dioica</i>	Zone 3 and 4	Gunung Gadung Forest	195 m asl
2	<i>Aerides odorata</i>	1	<i>Leea angulata</i>	Zone 4 and 5	Gunung Langgar Forest	167 m asl
3	<i>Cymbidium aloifolium</i>	2	<i>Antidesma petandrum</i>	Zone 2	Gunung Asakan Forest	178 m asl
			<i>Schleichera oleosa</i>	Zone 2	Gunung Nangka Forest	214 m asl
			<i>Tectona grandis</i>	Zone 3	Gunung Gadung Forest	195 m asl
			<i>Schleichera oleosa</i>	Zone 1	Gunung Lumut Forest	423 m asl
4	<i>Cymbidium sp.</i>	2	<i>Schleichera oleosa</i>	Zone 2	Gunung Lumut Forest	423 m asl
			<i>Tectona grandis</i>	Zone 4 and 5	Kastoba Forest	256 m asl
5	<i>Dendrobium anosmum</i>	1	<i>Tectona grandis</i>	Zone 4 and 5	Kastoba Forest	256 m asl
6	<i>Rhynchostylis retusa</i>	2	<i>Diospyros buxifolia</i>	Zone 2, 3	Gunung Nangka Forest	215 m asl
			<i>Diospyros buxifolia</i>	Zone 3	Gunung Nangka Forest	215 m asl
			<i>Syzygium sp</i>	Zone 1	Gadung Mount Forest	195 m asl
7	<i>Liparis condylobulbon</i>	1	<i>Irvingia malayana</i>	Zone 3 and 4	Gadung Mount Forest	195 m asl
8	<i>Pholidota imbricata</i>	1	<i>Irvingia malayana</i>	Zone 1,3,4	Pangambaan Mount Forest	266 m asl
9	<i>Taeniophyllum biocellatum</i>	1	<i>Canarium hirsutum</i>	Zone 3 and 4	Hutan Kastoba	285 m asl
10	<i>Eria sp.</i>	1	<i>Tectona grandis</i>	Zone 4	Pangambaan Mount Forest	266 m asl
11	<i>Hoya diversifolia</i>	1	<i>Ficus variegata</i>	Zone 1, 2 and 3	Payung-payung Mount Forest	197 m asl
12	<i>Hoya amoena</i>	1	<i>Ficus variegata</i>	Zone 1 and 2	Gunung Nangka Forest	207 m asl
13	<i>Hoya verticillata</i>	2	<i>Euria nitida</i>	Zone 3	Kastoba Forest	295 m asl
			<i>Ficus variegata</i>	Zone 4	Kastoba Forest	295 m asl
			<i>Antidesma petandrum</i>	Zone 3	Gunung Nangka Forest	207 m asl
14	<i>Dischidia imbricata</i>	2	<i>Antidesma petandrum</i>	Zone 3	Gunung Nangka Forest	207 m asl
			<i>Diospyros buxifolia</i>	Zone 4	Gunung Nangka Forest	207 m asl
			<i>Diospyros buxifolia</i>	Zone 3	Gunung Nangka Forest	207 m asl

### Epiphytic Orchids, Hoya and Dischidia in Bawean Island Nature Reserve and Wildlife Reserve

The most abundant epiphytic plant in Bawean Island Nature Reserve and Wildlife Reserve is *Phalaenopsis amabilis* that most often found in *Tectona grandis*. There were 3 species of host tree of *P. amabilis*, i.e. *Tectona grandis*, *Euonimus javanicus*, and *Garcinia dioica*. Besides that this species can grow in zone 1, 2, 3, 4 of host trees. The presence of *Phalaenopsis amabilis* is a species of epiphytic orchid species (Fig. 3a) indicates that the orchids are not only found on Borneo and Java islands. There is an abundance level of orchid species availability both in distribution and population on Bawean Island Nature Reserve. *P. amabilis* is a species of orchid having the most significant relative abundance (22.5%) compared to other epiphytic plants (Table 2). *Phalaenopsis amabilis* as known as *Anggrek Bulan* in local names as the

most preferable orchid by the community due to the beauty of flowers. This genus has a wide distribution in tropical forests (Fandani *et al.*, 2018), which is found in several areas including Sempu Island (Yulia, 2010), Batuputih Nature Park in Sulawesi with an altitude of 52-102 m above sea level (Yubu *et al.*, 2018), but can also be found in the middle altitude such as Petungkriyono Forest in Pekalongan with an altitude of 700-900 m above sea level (Mardiyana *et al.*, 2019).

*Rhynchostylis retusa* and *Dischidia imbricata* is the second abundant epiphytic plant in the study locations with relative diversity was 10%. *R. retusa* that can grow on zone 1,2,3, and well adapt in 2 species of host tree i.e. *Diospyros buxifolia* and *Syzygium sp*. This species can be found in several locations that indicated it has well adaptation in different host trees and habitat. *Dischidia imbricata* also can grow in 2 species of host trees (*Antidesma*



**Figure 3.** Diversity of Orchid, Hoya and Dischidia epiphyte. a) *Phalaenopsis amabilis*, b) *Aerides odorata*, c) *Cymbidium aloifolium*, d) *Cymbidium* sp., e) *Dendrobium anosmum*, f) *Pholidota imbricata*, g) *Taeniophyllum biocellatum*, h) *Rhynchostylis retusa*, i) *Dischidia imbricata*, j) *Hoya diversifolia*, k) *Hoya verticillata*.

*petandrum* and *Diospyros buxifolia*) on zone 3 and 4. *D. imbricata* is an adaptable plant that has a small leaf to reduce transpiration which supports its growth in low humidity and low water availability.

Some other species of epiphytic orchids found on Bawean Island were *Aerides odorata*, *Cymbidium aloifolium*, *Dendrobium anosmum*, *Pholidota imbricata*, and *Pholidota imbricata*. Compared with other studies of diversity epiphytic orchids on Java, the richness of epiphytic orchids on Bawean Island has almost the same number species of epiphytic orchids compared with other location on Java such as Sempu Island Nature Reserve which consists of 10 species, Gunung Lamongan forest area consisting of 7 species, Penanggungan forest area consisting of 9 species (Yulia, 2010), and Gunung Tukung Gede Nature Reserve consisting of 9 species (Sulistiari and Djarwaningsih, 2017). Sadili (2019), reported that there were only 4 species which found on Sempu Island. However, the species of epiphytic orchids on Bawean Island have lower numbers than

the number of orchid species found in the high altitude such as Semarang Gebugan Nature Reserve which consists of 11 species of orchids (Farokhah *et al.*, 2018), and the Conservation Area of Senduro which has 39 species of epiphytic orchids (Febriandito and Soetopo, 2019). This illustrates that Bawean Island has unique environmental conditions due to its location in a unique geographical location between Java and Borneo. Orchids on Bawean Island are priceless germplasm so that it need attention and preservation from the government.

One of the endemic orchids found on Java Island is *Taeniophyllum biocellatum* (Figure 3g.). On Bawean Island Nature reserve this species only found in 1 host tree (*Canarium hirsutum*) with 5% abundance. The population of this species is threatened due to forest exploitation. The discovery of *T. biocellatum* indicates that the presence of endemic orchids in Java is also spread in Bawean Island so that it can be seen that Bawean Island reflects as Java lowland forests. This species is dominants in Sempu Island and grow optimally in

sheltered condition (Sadili, 2019). Leaves of *T. biocellatum* are absent but they have green roots that contain chloroplasts. The presence of chloroplasts confirmed in the anatomical roots characters of *T. biocellatum* (Nurfadilah *et al.*, 2016). There must be conserve of the *T. biocellatum* in its natural habitat while maintaining the presence of trees serving as the host for the epiphytic orchid. *T. biocellatum* is very difficult to conserve outside its habitat (*ex situ*) that was indicated by poor adaptation in the acclimatization process in Purwodadi Botanic Garden.

**Table 2.** Abundance of epiphytic species in Bawean Island Nature Reserve and Wildlife Reserve.

No	Species of Epiphyte	Nt	No	% Ft	% Fo
1	<i>Phalaenopsis amabilis</i>	4	9	16	22.5
2	<i>Aerides odorata</i>	1	2	4	5
3	<i>Cymbidium aloifolium</i>	1	1	4	2.5
4	<i>Cymbidium</i> sp.	3	3	12	7.5
5	<i>Dendrobium anosmum</i>	1	2	4	5
6	<i>Rhynchosstylis retusa</i>	3	4	12	10
7	<i>Liparis condylobulbon</i>	1	2	4	5
8	<i>Pholidota imbricata</i>	1	3	4	7.5
9	<i>Taeniophyllum biocellatum</i>	1	2	4	5
10	<i>Eria</i> sp.	1	1	4	2.5
11	<i>Hoya diversifolia</i>	1	3	4	7.5
12	<i>Hoya amoena</i>	1	2	4	5
13	<i>Hoya verticillata</i>	2	2	8	5
14	<i>Dischidia imbricata</i>	4	4	16	10

Nt = The number of trees in the plot hosting a particular epiphytic species.

No = The number of individuals of a particular epiphytic species within the plot.

% Ft = Relative frequency of phorophytes.

% Fo = Abundance of epiphytic plants.

There are only 3 species of Hoya and 1 species of *Dischidia* that recorded in Bawean Island i.e. *Hoya diversifolia* (Figure 3j), *H. verticillata* (Figure 3k), *H. amoena*, *Dischidia imbricata* were found in the forest of Bawean Island with abundance ranges between 5-10%. Compared with other locations, the diversity of Hoya in Bawean Island is relatively low. The number of Hoya species in other location including Bodogol Conservation Area recorded 6 species (Sulaeman *et al.*, 2019), Belitung Island recorded 5 species (Rahayu *et al.*, 2018), Gunung Gede Pangrango recorded 10 species (Rahayu, 2012), Sumatra included 41 species and 2 subspecies

(Rahayu and Rodda, 2019), and Borneo included 34 species (Lamb and Rodda, 2016).

Hoya is a succulent plant having the ability to grow on less moist or dry conditions. Hoya can also live as terrestrial plants, but most of them were found in nature as epiphytic plants. It has a sticky root on the trunk, which is used to attach itself to the host tree. Hoya plants are also called “wax plants” due to the waxy appearance of their leaves or flowers (Panajon *et al.*, 2016). The leaf characteristic of the three species of hoya is succulent, which means it can store water in its organs (Fahn, 1991), which function to adapt to extreme conditions (Keraudren, 1990). Succulence also associated with ecophysiological strategies and occurs in plants that have evolved in many different environments condition (Griffiths & Males, 2017). A previous study from Sulaeman *et al.* (2019) in Bodogol Conservation Area reported that air humidity and canopy cover is abiotic factors that most influencing *Hoya's* existence. The presence of *Hoya campalunata* has the highest correlation with wind speed and air temperature. *Hoya multiflora*, *Hoya vitellinoides*, *Hoya hasseltii*, and *Hoya imperialis* have positively correlated with air humidity and canopy cover.

### Host Trees (Phorophyte) Species

There were 12 species recorded as host plants of epiphytic species. The preferable tree species as a host tree by the epiphytic species are *Tectona grandis*, *Irvingia malayana* and *Diospyros buxifolia* (Table 3). *T. grandis* had the highest species richness of epiphytic orchids, 4 species had been recorded growing on this phorophyte. *Tectona grandis* or often referred to as teak trees is also an orchid host tree in Bawean Nature Reserve. *T. grandis* is cultivated by people surrounding the forest as a community forest (*butan rakyat*). Teak (*Tectona grandis*) is one of the most economic tropical hardwood which has naturally distributed from India through Myanmar, Laos, and Thailand (Deb *et al.*, 2017). There were 4 species of orchids attaching on teak trees, i.e. *Phalaenopsis amabilis*, *Dendrobium anosmum* and *Cymbidium* sp., and *Eria* sp. Among other species, teak is the preferable tree by epiphytic plants. In teak trees, there are often found seedlings of *P. amabilis* and *D. anosmum* in their trunk. This proves that *T. grandis* is a suitable host for epiphytic orchid growth. At the Meru Betiri National Park in East Java, *T. grandis* is a tree that is often seen as a host for epiphytic orchids among other trees (Puspitaningtyas, 2007). Orchid seeds require special conditions to germinate because of mycoheterotrophic character which during the growth stage, the seeds have a depend on fungi as a source of carbohydrates for orchid growth (Dearnaley *et al.*, 2016).

**Table 3.** Host trees (phorophytes) in Bawean Island with these parameters.

No	Host Trees	Jt	Js	Ji	Js/Jt	Ji/jt
1	<i>Antidesma petandrum</i>	3	2	3	0.67	1.00
2	<i>Canarium hirsutum</i>	1	1	1	1.00	1.00
3	<i>Diospyros buxifolia</i>	4	2	5	0.50	1.25
4	<i>Euonimus javanicus</i>	1	1	1	1.00	1.00
5	<i>Euria nitida</i>	1	1	1	1.00	1.00
6	<i>Ficus variegata</i>	2	2	3	1.00	1.50
7	<i>Irvingia malayana</i>	2	2	5	1.00	2.50
8	<i>Leea angulata</i>	1	1	1	1.00	1.00
9	<i>Schleicheria oleosa</i>	3	2	3	0.67	1.00
10	<i>Syzygium</i> sp.	1	1	1	1.00	1.00
11	<i>Tectona grandis</i>	5	4	10	0.80	2.00
12	<i>Garcinia dioica</i>	1	1	1	1.00	1.00

Jt = Number of host trees for epiphytic plants.  
 Js = Number of epiphytic plant species.  
 Ji = Number of individual epiphytic species.  
 Js / Jt = Average number of epiphytic species in host plants.  
 Ji / Jt = Average number of epiphytic individuals in the host plants.

The second preferable tree species as a host tree is *Diospyros buxifolia*. This tree is the host of the *Rhynchosyris retusa* and *Dischidia imbricata*. *D.buxifolia* is suitable for the growth of orchids and hoya due to its trunk surface has a rough character which makes it easy for epiphytic roots to stick to stem surface. *Dischidia imbricata* is an epiphytic plant that has a small root character, so it requires a suitable stem to be able to attach the roots. Genus of *Diospyros* is the largest, most widely distributed, and economically trees of Ebenaceae family (Tang *et al.*, 2019). *D. buxifolia* has branching with a circular arrangement at interval 15-20 cm. This species has black coloured in the stem, smooth surface, and shallow grooved (Kinho, 2013). This circular branching arrangement allows sunlight to enter the canopy and affect the air humidity level around the canopy that suitable for the growth of *R. retusa* and *D. imbricata*.

The third preferable tree species as a host tree is *Irvingia malayana*. The largest individual numbers of epiphytic orchids was also found in *I. malayana*. This species is suitable for epiphytic growth, especially orchids, i.e. *Liparis condylobulbon* and *Pholidota imbricata*. *I. malayana* is the dominant tree in the Bawean Island forest with a large diameter. Its called in local name as “red wood” (*babasa: kayu merah*). In

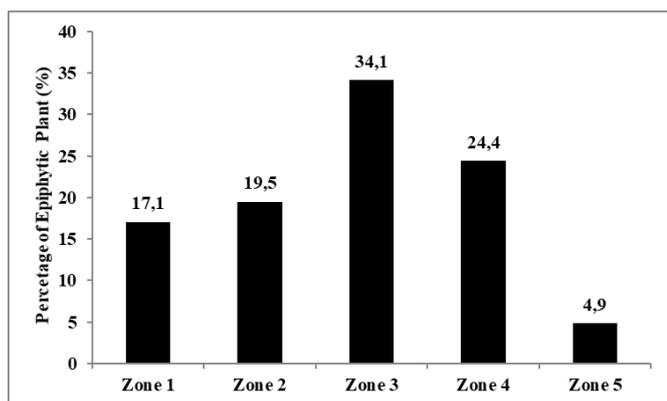
addition, this species also has a reasonably large wood density of 0.84 g cm<sup>-3</sup> (Zanne *et al.*, 2009). *Irvingia malayana* fruit is a favorite feed of endemic deer (*Axis kuhlii*) of Bawean Island. The presence of endemic deer (*Axis kuhlii*) is expected to play a role in the distribution of seeds of the species of *Irvingia malayana* (Trimanto, 2014). This deer knew as Critically Endangered status on the IUCN Red List (Rahman *et al.*, 2017a; 2017b). Based on the inventory of orchid in East Borneo, *Irvingia malayana* is the most tree for a host of epiphytic plants. There are at least 10 species of epiphytes growing in *Irvingia malayana*. It indicates that *I. malayana* has characteristics of having a suitable trunk surface for epiphytic growth (Trimanto & Sofiah, 2018).

One of the host trees is *Euonimus javanicus* found in Gunung Lumut Forest. Bark surface of *E. javanicus* becomes a growing place of moss making it suitable for epiphytic plants. *P. amabilis* grew on this bark. In other studies, the condition of the stem that stuck by *Hoya purpureofusca* has a rather to very rough skin stem. The surface of the bark of the host tree covered 20-70% by moss so that it can support the growth of *H. Purpureofusca* (Hidayat *et al.*, 2012). *Schleicheria oleosa* (Kesambi) is a host tree by *Cymbidium aloifolium*. *S. oleosa* can reach up to 40 m in height, up to 2 m in diameter. Skin bark was smooth, gray, and wrinkled (Suita, 2012), that suitable for the growth of epiphytic orchids. Morphology of trees influencing the presence of epiphytic plants such as stem diameter, crown and branch shape. The presence of epiphytic plants is also influenced by microclimate, while the microclimate of the forest depends on vegetation conditions such as crown density and shape crown. Skin bark of a tree with rough and cracked surface, and has many indentation and scar will be filled by humus which suitable for epiphytic plants (Sujalu, 2017).

### Vertical Distribution of Epiphytic Orchids, Hoya and Dischidia on Host Trees (Phorophyte) Species

The present study showed a range of vertical distribution of epiphytic orchid, Hoya and Dischidia from zone 1 to zone 5 (Table 4). The epiphytic orchid grew on zone 1 to zone 5, while epiphytic Hoya grew on zone 1 to zone 4, and epiphytic Dischidia grow on zone 3 to zone 4. The most abundant orchid *Phalaenopsis amabilis*, was found to have the widest vertical distribution ranging from zone 1 to zone 4. Most epiphytic orchid species grew on zone 3 and zone 4. A small number of orchid species occurred on the trunk (only two orchids species grew on zone 5). The epiphytic Hoya most grew on zone 1-3, but only 1 species grew on zone 4. Hoya was not found in zone 5. The

epiphytic *Dischidia* only grew on zone 3 and 4. Based on other studies epiphytic orchid in Coban Trisula and Mexico, where vascular epiphyte abundance was higher in zone 3-5 (tree crown) than in zone 1-2 (along the trunk) due to enter light intensity nearby the tree crown (Nurfadilah, 2016; Manzano *et al.*, 2014), but in Bawean Island forest, the abundance of epiphytic orchid is the least on zone 5 compare to other zones. Two species of orchid that grew on zone 5 is *Aerides odorata* and *Dendrobium anosmum*.



**Figure 4.** Comparison of the frequency of epiphytic presence in the phorophytes zone.

The presence of epiphytes was often grown on zone 3 and 4 (Figure 4). Zone 3 is the central area or in the main trunk branching area of phorophytes that has an optimum level of light intensity for epiphytic plants growth. Zone 3 is the first branching of a tree, which provides sufficient surface area to stick the epiphytic roots. Epiphytic orchids were mostly found in this zone. The highest frequency of epiphytic plant (Orchids, Hoya, and

*Dischidia*) were present in zone 3 with percentage was 34.1 %. There were 9 species that grew on this zone. Zone 3 provides optimum environmental conditions for epiphytes growth. In the branching area, it usually contains more humus subtract and other epiphytic plants such as ferns so it provides enough moisture for epiphytes growth. Skin roughness and substrate fields serve as important factors that influence the abundance level of epiphytic orchids (Manzano, 2014). The second largest percentage zone is zone 4, it was also about 9 species grew on zone 4 with percentage were 24.4 %. The presence of epiphytic plants on phorophytes is determined by branches containing humus and moisture substrate that are accumulated from other epiphytic plants such as fern. Humus and moisture substrate in phorophytes supporting the growth of epiphytic plants. In this case, *Dischidia imbricata* only grew on zone 3 and zone 4. Zone 1 is the lowest or base area of the tree (1/3 of the main trunk). This zone has a low intensity of light and very close to the soil surface. Zone 1 is the habitat transition for epiphytic plants that previously as terrestrial plants and then change as epiphytic plants. At the beginning of its growth, Hoya grows and develops on the soil surface and then spread to the trunk surface of host trees. This zone is very suitable for Hoya, which starts to adapt from terrestrial habitat (soil) to an epiphyte habitat. In Zone 1, it is also found 4 species of orchids and 2 species of Hoya, i.e. *Pholidota imbricata*, *Cymbidium* sp., *Rhynchostylis retusa*, *Phalaenopsis amabilis*, *Hoya diversifolia* and *H. amoena*. Zone 2 has moderate light intensity so that some of the species can growth optimum in this zone. Zone 2 also has a greater surface area for epiphyte root. In Zone 2, the percentage of

**Table 4.** Zones of the occurrence of epiphytic orchids, Hoya and *Dischidia* on their phorophytes and the number of individuals in each zone.

No	Species of Epiphyte	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
1	<i>Phalaenopsis amabilis</i>	2	3	2	2	
2	<i>Aerides odorata</i>				1	1
3	<i>Cymbidium aloifolium</i>		2			
4	<i>Cymbidium</i> sp.	1	1	1		
5	<i>Dendrobium anosmum</i>				1	1
6	<i>Rhynchostylis retusa</i>	1	1	2		
7	<i>Liparis condylobulbon</i>			1	1	
8	<i>Pholidota imbricate</i>	1		1	1	
9	<i>Taeniophyllum biocellatum</i>			1	1	
10	<i>Eria</i> sp.				1	
11	<i>Hoya diversifolia</i>	1	1	1		
12	<i>Hoya amoena</i>	1	1			
13	<i>Hoya verticillata</i>			1	1	
14	<i>Dischidia imbricate</i>			3	1	
Total number of epiphytic plant		7	8	14	10	2

epiphytes presence is large with a percentage of 19.5%. In location studies, there were 3 species of orchids and 2 species of hoya grows on zone 2 i.e. *Phalaenopsis amabilis*, *Cymbidium aloifolium*, *Rhynchostylis retusa*, *Hoya diversifolia* and *Hoya amoena*. Zone 2 is also a suitable habitat for *Cymbidium aloifolium* which is proven that orchid species were rarely found in the upper zone of the phorophytes.

The smallest presence of epiphytes in zone 5 (the outermost area of the branching) due to this zone has the smallest surface area. There were only 2 species of epiphytes present in this zone due to this zone is not sheltered by a crown of phorophytes, i.e. *Aerides odorata* and *Dendrobium anosmum*. This zone has high light intensity and low air humidity level because of the character forest of Bawean Island is lowland and dry so that not supporting for growth of epiphytic plants in this zone. Zone 5 is actually the safest area to avoid epiphytic plants from human exploitation. This zone is blocked by small branches and leaves.

### Implication for Conservation

It is necessary to maintain the sustainability of forest trees in order to protect it from exploitation because trees are host plants of various epiphytic plants in the forest. Preservation of forest trees and epiphytic plants can involve the local community. Orchids, Hoya, and Dischidia on Bawean Island are sources of germplasm that must be conserved because these epiphytic plants have genetic sources that may be different from similar epiphytic plants in other regions.

### CONCLUSION

There were 10 species of epiphytic orchids, 3 species of Hoya, and 1 species of Dischidia that have been recorded in Bawean Island Nature Reserve and Wildlife Reserve. The most commonly found of epiphytic orchid in location studies is *Phalaenopsis amabilis*. There were 12 species of trees as the hosts of epiphytic plants. *Tectona grandis*, *Irvingia malayana*, and *Diospyros buxifolia* were the trees that often found as the host of epiphytic plants. Zone 3 is the area covering the basal part of the branching (1/3 part of the total length of the branch) serves as the zone which is the most often found epiphytic plants. The least epiphytic presence is found in Zone 5.

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